Title:

Epiphyseal stress fractures of the fingers in an adolescent climber: A potential 'Maslows Hammer' in terms of clinical reasoning

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Context

Climbing is an increasingly popular physical activity amongst young people with indoor competition climbing accepted for inclusion at the Olympic Games in Tokyo in 2020. Current trends show that the average age of elite rock climbers is decreasing with many international competition winners now being adolescents. The epidemiology of injury in adult climbers has been determined (1). However, a paucity of published evidence in respect of adolescent climbing related injuries exists. A critical review of the incidence, diagnosis, and management of injury in sport climbing and bouldering highlighted the importance of early diagnosis of epiphyseal fractures of the proximal interphalangeal joint (PIP) in adolescent sport climbers (2). Fractures of the epiphysis of the fingers normally present following an acute traumatic episode. In contrast, the aetiology of injury in adolescent climbers is likely due to high load repetitive stress (3).

It is argued that Health Care Professionals unfamiliar with the nature of climbing related injuries may fail to consider the possibility of a fracture based on the presenting aetiology. In turn this may lead to misdiagnosis, incorrect advice and the risk of serious negative consequences. As the psychologist Maslow said, “If the only tool you have is a hammer, you tend to treat everything as if it were a nail.” In this context Maslow’s hammer would be confirmatory bias of incorrect pattern recognition. Injuries of the epiphysis need to be identified early and managed appropriately to avoid premature closure, growth arrest and subsequent deformity of the finger.

The Case

A sixteen-year-old right handed male requested a Consultant review due to concerns regarding ongoing pain, mild swelling and irritation in the PIP joint of his left middle finger over a 12-month period. The patient was an elite level climber and boulderer engaged in

regular training and competitions. There was no recall of a single incident which precipitated the pain, no fall or trauma, but a gradual onset of discomfort at the PIP joint which came on after climbing. He was healthy, had no other underlying medical concerns, took no regular medications, did not smoke and had no allergies. The onset of pain did coincide with the commencement of a pubertal growth spurt.

Throughout the initial onset of pain, the patient had self-managed using tape to support his finger and tried to avoid the use of the crimp grip which exacerbated the pain. He occasionally used mild analgesics intermittently for pain relief. In the crimp grip position the proximal interphalangeal joint is flexed to approximately 100° and the distal interphalangeal joint (DIP) is hyperextended by approximately 40°.

[Insert Figure 1 here: Common climbing grip types]

Force distribution in this position is greatest on the middle and ring fingers. The pain persisted for several weeks and so his parents arranged a General Practitioner (GP) appointment. The parents were climbers and had sourced information regarding epiphyseal injuries in adolescent climbers from the British Mountaineering Council web site. In consideration of this information provided by the parents the GP arranged an X-ray of his finger. This was reported as showing a Salter-Harris III epiphyseal fracture at the base of the middle phalanx. The GP advised rest but without a clear explanation of the sequela if growth arrest was to occur. Despite this he continued to climb to a high standard and use simple analgesia (paracetamol and ibuprofen) as required.

A repeat x-ray was organised nine months later as his symptoms persisted, but the fracture was still visible. On his parent's advice he ceased all climbing activities.

On examination he had point tenderness on the dorsal aspect of the PIP joint of his left middle finger approximate to the region of the attachment of the central slip of the extensor digitorum tendon. The central slip was functioning well and both flexor digitorum superficialis and profundus tendons were functioning normally. The collateral ligaments and volar plate were clinically stable. A plain radiograph was ordered and confirmed a Salter-Harris III epiphyseal plate fracture, which had been visible on the two previous films.

[Insert Figure 2 here: Plain Radiograph Salter Harris type III fracture at the base of the middle phalanx]

An MRI was performed confirming the diagnosis. The MRI was also useful to exclude potential associated soft tissue injuries to the volar plate, collateral and accessory collateral ligaments, or the flexor pulley system: (distal A2, A3 or proximal A4).

[Insert Figure 3 here: MRI confirming Salter-Harris type III fracture at the base of the middle phalanx]

Radiographic evaluation confirmed that the epiphyseal plates were closing and as he reaches skeletal maturity the consultant clinically reasoned the fracture should heal satisfactorily. The patient was advised to completely rest from climbing for 2-3 months and gradually return to activity but avoid use of the crimp grip position and utilise a more open palm technique (see Fig. 1). He was reviewed in clinic recently and the fracture is resolving satisfactorily.

[Insert Figure 4 here: Plain Radiograph confirming healing Salter Harris type III Fracture at the base of the middle phalanx]

What was learned from this case?

Our case highlights the typical aetiology associated with stress fractures of the epiphysis of the PIP joint seen in adolescent climbers. Current advice from the British Mountaineering Council suggests that pain in the PIP joint of an adolescent climber which does not respond to a week of rest should be reviewed clinically and appropriate imaging taken to actively rule out an epiphyseal fracture. It is important to note that Salter Harris III growth plate fractures may not be immediately evident on plain films. Adolescent climbers with open physes and painful PIP joints in whom no fracture is immediately apparent on a plain film should undergo an MRI scan to detect a potential occult fracture. The use of a wrist coil is recommended to improve the quality of the MRI image. Subsequent MRI scans may be necessary to confirm healing in cases where an initial plain film was negative, but the MRI confirmed a fracture. Further imaging may be necessary in cases of on-going pain, clinical concern or a pressing need to return to climbing. It appears fortunate in this particular case that the parents considered the possibility of a fracture to their son's finger owing most likely to the fact they are climbers. It is unknown if a GP would have considered this diagnosis without this information. However, we suggest in many cases this would be unlikely due to unfamiliarity with climbing injuries and the use of pattern recognition methods of clinical reasoning, which might consider a pulley injury rather than a growth plate fracture.

Clinical examination usually reveals pain on the dorsal aspect of the proximal interphalangeal joint of the middle or ring finger. Occasionally localised swelling and tenderness may be present and associated with a pubertal growth spurt. We suggest an MRI should be routinely performed and used to confirm diagnosis in cases where plain radiographs do not reveal a fracture. A Salter-Harris type III physeal fracture of the middle phalanx is the most common presentation reported in adolescent climbers to date. For non-displaced fractures, we further

recommend initial cessation of all climbing activity followed by a gradual return to activity with load modification until fracture healing or closure of the growth plate is confirmed. A resting splint may be used in the first 3-4 weeks following diagnosis, removal of the splint four times daily to perform tendon-gliding exercises is recommended. Climbers should avoid deep crimps and be encouraged to train with a more open palm technique. Despite surgical intervention using percutaneous spot drilling epiphysiodesis showing encouraging results (4), fusion of the epiphysis should be considered only in cases where there is clear evidence of abnormal differential bone growth.

The International Olympic Committee recommend monitoring athletic load in competitive athletes to reduce injury occurrence. Inappropriate repetitive load is the primary stimulus leading to fractures of the epiphysis in adolescent climbers. For competitive climbers routinely monitoring acute/chronic workloads and weekly completion of the Oslo Sports Trauma Research Centre questionnaire on health problems as an adjunct tool may detect early signs and symptoms. Chronic overuse injuries result from repetitive and forceful exertion on the body over time, this leads to mal-aligned healing and tissue damage. It is common for climbers to continue in their given activity whilst perceiving some level of pain or discomfort in the fingers. Therefore, adolescent climbers may not consider themselves to be in an injured state. Climbers, with a long symptomatic history of dorsal finger pain, and who have continued to climb unrestricted, are at an increased risk of sustaining a partial or complete separation of the epiphysis

In our case, cessation of climbing and continued activity modification has resulted in successful healing of the fracture and avoided the long-term adverse consequences of a missed growth plate injury. At his most recent review the pain had settled and the patient had

returned to climbing with an open palm technique, pain free. Radiologically the physes are closing and the fracture has united.

Figures

Figure 1: Common Climbing Grip Types

Figure 2: Plain Radiograph with Salter Harris type III fracture at the base of the middle phalanx

Figure 3: MRI confirming the Salter-Harris type III fracture at the base of the middle phalanx

Figure 4: Plain Radiograph confirming healing Salter Harris type III Fracture at the base of the middle phalanx

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